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Effectiveness of supplemental parent training in hearing aid listening checks

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Effectiveness of Supplemental Parent Training

In Hearing Aid Listening Checks

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Previous research has indicated unreliable and inadequate performance of children's hearing aids. These studies have shown that as many as 50% of hearing-impaired children's hearing aids are performing unsatisfactorily. Daily listening checks have been routinely recommended to provide a means for ensuring that the child's hearing aids are functioning properly. While school aged children may receive hearing aid monitoring services from school personnel, often the task of monitoring the actual hearing aids falls upon the parents. There has been little actual data on the effectiveness of parent training to perform an adequate check of hearing aid functioning.

This study investigated the effectiveness of a parent training program in establishing the effectiveness of a parent training program in establishing the behaviors necessary to perform adequate listening checks on hearing aids. A single subject, alternating treatments design was used with two sets of parents of hearing-impaired children to determine the effectiveness of two different training programs in teaching the behaviors necessary to perform a listening check of behind the ear hearing aids (BTEs).

Findings indicated that parent training was effective in increasing the listening check behaviors as demonstrated by the subjects. Clinician training and clinician training combined with supplemental videotaped training appeared to have similar effects on increasing the performance of listening check behaviors. The subjects ability to detect actual malfunctioning hearing aids also increased. The results indicated that while supplemental videotaped training did not demonstrate a marked increase in listening check behaviors over clinician training alone, parent training is indeed effective in increasing the behaviors necessary to provide an adequate hearing aid inspection, and in detecting actual malfunctions.

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Chapter I: Introduction

A major concern among educators, speech-language pathologists and audiologists who work with hearing-impaired infants and children is ensuring that hearing aids worn by these children are functioning properly. While it is agreed among professionals that the proper fit and maintenance of hearing aids are essential elements in any child's aural (re)habilitation program, several studies have reported unreliable and inadequate performance of hearing aids used in the classroom (Bess, 1977; Porter, 1973; Zink, 1972; Gaeth and Lounsbury, 1966). These studies have estimated that as many as 40 to 50% of the children's hearing aids in the educational setting are performing unsatisfactorily.

While hearing aids can be analyzed electroacoustically at various intervals, daily hearing aid checks including both visual and listening assessments have been routinely recommended to provide a means for ensuring that the child's hearing aids are functioning properly. A visual assessment involves the inspection of each visible component of the hearing aid for defects. A visual check will often reveal those defects caused by dead batteries, frayed cords and poorly fitting earmolds (Kemker, McConnell, Logan, and Grann, 1979). A listening assessment entails listening to the actual sound output from the hearing aid with the sound controls in various positions allowing identification of defective or broken controls and distortion. Bess and

McConnell (1981) indicated that up to 48% of the hearing aids which were found to be defective in the classroom setting were defective due to electroacoustical malfunctions. These defects are only identified by an electroacoustic analysis or by an extensive listening check of the hearing aid's performance.

Several studies have indicated that the operating status of hearing aids used in the classroom have not improved in the last fifteen years and suggested that listening checks thus far have been far from adequate (Busenbark and Jenison, 1985). The actual responsibility of monitoring a child's hearing aids has been placed upon parents, the classroom teacher, the speech language pathologist and educational audiologist. Elfenbein, Bentler, Davis, and Niebuhr (1986) found that a large number of hearing-impaired childrens' hearing aids were rarely or never checked by any school personnel including the school based speech pathologists. With these statistics and the varying frequency of professional contact, it has been suggested that the actual task of monitoring the hearing aids should fall to the parents (Niswander 1989). In addition, the habilitation programs designed to train the parents of hearing-impaired children often recommend that parents perform a daily hearing aid check (Thompson, Atcheson & Pious, 1985; Clark and Watkins, 1978).

There is little actual data available regarding the effectiveness or the adequacy of parent training in the areas of hearing aid monitoring. Those parents who have infrequent contact with professionals or who participate in home based intervention often become solely responsible for monitoring their children's amplification (Niswander 1989). Training in hearing aid monitoring should serve to familiarize parents with the function of hearing aids and help them to become comfortable with their daily use. Unfortunately, most parents do not receive appropriate nor adequate training in hearing aid visual and listening checks. The development and implementation of an effective parent training program in the area of hearing aid listening checks is clearly needed if the hearing-impaired child's habilitation program is to be effective in overcoming the difficulties imposed by the child's hearing loss.

The purpose of this study was to investigate the effectiveness of one parent training program in establishing the behaviors necessary to perform appropriate hearing aid listening checks. Specifically, this study investigated whether or not supplemental videotaped training improved the learning curve of listening checks by parents of hearing-impaired children.

Chapter II: Literature Review

One of the most important advances in the education of deaf children came with the advent of amplification in the 20th century. While early hearing aids were not comparable to the amplification systems available today, their use sparked early research regarding the use of residual hearing. In an early study, Ewing, Ewing and Littler (1936) surveyed the audiometric characteristics of the pupils enrolled in the schools for the deaf through the United Kingdom. Their study revealed that only a small minority of students in the deaf schools were totally deaf. Similar data were collected during that period in the United States. (Hughson, Ciocco, and Palmer, 1939). More recent data indicate that 96% of hearing impaired children have some amount of residual hearing (Clezy 1984, Office of Demographic studies, 1971). The majority of hearing-impaired children may then be able to use amplification in order to make maximum use of their residual hearing. A child with any residual hearing can derive some benefit from amplified sound, even though audition may only serve as a supplement to compensatory modes on communication. Ling and Ling (1978) stated that amplification is the most important tool available to hearing-impaired children.

While the fitting of high quality amplification systems may be becoming more prevalent, hearing aids are only effective when they are maintained and used consistently. If hearing-impaired children are to obtain maximal benefit from amplification, their hearing aids must be monitored and checked daily.

Hearing Aid Functioning

One of the earliest studies which examined the performance of children's hearing aids was done by Gaeth and Lounsbury in Detroit in 1966. They assessed the function of hearing aids from 134 children, ranging from 3 to 18 years of age. They found that more than half of the hearing-impaired children participating in their study were not receiving the maximum benefit available from their hearing aids. Only 31% of the children were judged to have adequately functioning hearing aids, while 69% of the children had hearing aids which were considered unsuitable when evaluated by an electroacoustical analysis. Gaeth and Lounsbury also had the parents of these children complete a questionnaire which assessed the parent's knowledge of hearing aids. Their responses revealed that they were poorly informed about all aspects about their children's hearing aids. In a similar study done in 1969, Martin and Lodge reported that an average of 50% of the hearing-impaired children in schools and classrooms for the hard of hearing in the United Kingdom were not making proper use of their hearing aids due to the defects in or incorrect use of their hearing aids.

Zink (1972) analyzed the hearing aids of hearing-impaired students in a regular school setting. He evaluated the electroacoustic performance of 195 hearing aids over a two year period of time. He used the following criterion to assess malfunctions in the hearing aids performance:

1. an increase or decrease in the gain of the hearing aid of more than 15 dB, or two or more increases or decreases of greater than 6 dB,
2. gain and output measures not within 6 dB of manufactures's specifications,
3. a measure of harmonic distortion of more than 17% at any one frequency, and
4. a gain control taper which did not demonstrate adequate linearity to provide sufficient reserve gain.

During the initial year of the study, Zink evaluated 103 hearing aids and found that 60 (59%) did not meet his criteria. Fifty-two of these 60 hearing aids were examined after their repair, and 18 (35%) still failed to meet the above criteria. In the second year of the study, Zink evaluated 92 hearing aids. At that time, 41 (45%) hearing aids did not meet his criteria for acceptable performance. Zink attributed the slight improvement in hearing aid performance (13%) from the first year of the study to an increased awareness on the care and maintenance of the hearing aids by the teachers, parents, and children.

In 1973, Porter evaluated the hearing aids worn by the children at the Kansas School for the Deaf. Each hearing aid was examined through a visual inspection, a listening check, and an electroacoustic analysis. In the listening check, a hearing aid was judged to inadequate if acoustic feedback was detected at anytime during the evaluation. Hearing aids were also judged to be inadequate if the battery was dead, if the signal was overly distorted at the hearing aid's output, if the hearing aid provided very low gain, or if the hearing aid operated intermittently during the listening check. An electroacoustic analysis was used to determine the frequency response curves and maximum power outputs of the hearing aids. The hearing aid failed if it deviated significantly from its previous analyses performed earlier in the study. The results of this study revealed that 42 (51%) of the hearing aids assessed had problems which were easily observable and were detected by the visual and listening inspection. It was noted that the problems detected did not represent any major electroacoustic malfunctions, however. Instead the problems included such things as dead batteries, inadequate earmolds, broken switches and cords or volume controls. Porter emphasized that these malfunctions were both easily detected and and can be readily corrected. Ten (8%) hearing aids passed the visual and listening inspection but still failed to meet manufacturers specifications when evaluated electroacoustically. The electroacoustic problems generally included a significant change in the frequency response, (typically seen as a reduction of the low frequency gain) or high harmonic distortion at the user setting.

Kemker, McConnell, Logan, and Green (1979) conducted a five year study in the Nashville Tennessee school system. For the first three years, they performed weekly listening checks on the hearing-impaired children's hearing aids, while they were educating the children, teachers and parents about hearing aid functioning and monitoring. During the last two years of the study, they performed daily listening checks on the hearing aids. They found that 61% of the problems noted were due to weak or dead batteries over the five year period. Another 26% of the problems were due to mechanical defects, while 13% of the problems were attributed to earmold defects. While 72% of the hearing aid malfunctions were due to dead batteries during the first year of the study, during the fifth and final year of the study, only 44% of the malfunctions were due to dead batteries. The drop in hearing aid defects supported the need to educate parents, teachers and clinicians in hearing aid monitoring techniques.

In 1980, Robinson and Sterling replicated Gaeth and Lounsbury's study in Detroit. They examined 98 hearing aids from hearing-impaired children. They found that 40% of the hearing aids were not functioning appropriately. In addition, 38 parents reported that their children were wearing their hearing aids only at school. They were not wearing their hearing aids in other situations.

In 1983, Potts and Greenwood examined 66 hearing aids on 44 students. They implemented a hearing aid monitoring program which looked at three different levels of examining hearing aids:

1. Routine monitoring including battery voltage, quick visual inspection and listening with a stethoscope,
2. More specific visual and listening examination, including the Ling five sound test and a visual checklist, and
3. Electroacoustic analysis.

Overall, they found that 25% of the hearing aids were functioning unsatisfactorily. They identified a variety of problems which contributed to this poor performance including cracked tubing, frayed cords, distortion, weak or dead batteries and broken parts. The data collected one year later, however, revealed that the rate of defective hearing aids had dropped to 12%, indicating that the monitoring program had been effective in reducing the overall number of hearing aid malfunctions.

In summary, these studies (Gaeth and Lounsbury, 1966;

Martin and Lodge, 1969; Zink, 1972; Porter, 1973; Kemker, et al., 1979; Robinson and Sterling, 1980; Potts and Greenwood, 1983) have revealed little or no improvement in the performance and functioning of hearing aids worn by hearing-impaired children at least through the 1980's. In addition, there is essentially no data which suggest that hearing aid monitoring and functioning has markedly improved in the last ten years. Still some data suggest that hearing aid monitoring programs can be effective in reducing the number of hearing aid malfunctions.

Responsibility for Hearing Aid Maintenance

While the eventual goal of hearing aid monitoring programs is to make the hearing-impaired children responsible for their own monitoring of the functioning of their hearing aids, they are not likely to do so unless the process is taken seriously and demonstrated to be important. The responsibility of monitoring a child's hearing aids has been placed upon a variety of individuals. Some programs have place the primary responsibility for providing hearing aid maintenance on the classroom teacher who comes into daily contact with the hearing-impaired child (Lass, Tecca & Woodford, 1987; Potts and Greenwood. 1983; Bendet, 1980). The school speech-language pathologist has also been frequently assigned the responsibility for monitoring the children's hearing aids while they are in school. This recommendation resulted from the need to use personnel who reportedly should have specialized training in conducting listening checks (Woodford, 1987). It should be noted; however, that the American Speech-Language-Hearing Association requires only six semester hours in audiology classes in order to obtain the Certificate of Clinical Competence in Speech-language-Pathology. Three of these six semester hours must include diagnostic audiology (assessment of auditory disorders and pathologies) while the other three semester hours must have content in habilitation/rehabilitation procedures for speech and language problems associated with hearing-impairment (ASHA, 1975). These requirements are nonspecific, and in some cases may not include any training in amplification and assistive listening devices.

In most cases; however, the literature and personal observations suggest that speech-language pathologists do not feel comfortable or are capable of adequately monitoring hearing aids, and usually feel that the audiologist should be the professional responsible for this maintenance (Tourne', 1988). The educational audiologist, when available, is assumed to be the most qualified individual for taking on the responsibility for hearing aid maintenance programs. The educational audiologist, by definition, should have the necessary training and professional expertise for the management hearing aids in the public school setting (Ross, 1976). Although the school based audiologist is the professional of choice due to his/her specific training and knowledge concerning hearing aid fitting and maintenance, a single audiologist is usually responsible for the hearing impaired children enrolled in several schools and is typically unable to meet the maintenance needs of the hearing aids belonging to hearing-impaired children on a daily basis. As a result, the responsibility for hearing aid maintenance has generally fallen back upon those school personnel who have more direct contact with the hearing-impaired children such as the classroom teacher or the speech-language pathologist. Previous research however reveals that classroom teachers and speech-language pathologists generally lack the basic knowledge of hearing aids and demonstrate relatively poor skills in routine monitoring of hearing aids.

Jones (1982, cited in Berg, et al., 1986) investigated the hearing aid monitoring skills of regular classroom teachers and found that they have little or no knowledge of hearing aids. In 1987, Lass et al. performed a similar study which examined teachers knowledge of hearing impairment. Their results indicated that teachers were deficient in their knowledge regarding where a hearing-impaired child could obtain hearing aids and the role of the audiologist in the management of the hearing-impaired child.

Busenbark and Jenison (1986) assessed the reliability for hearing aid checks made by classroom teachers and teacher aids. They asked each teacher/aide to perform listening checks on several defective hearing aids, and then had them reassess the same hearing aids at a later date. They found that the classroom teachers and their aides displayed poor consistently in assessing the electroacoustic performance (listening check) of the hearing aids.

Similar results were found among speech-language pathologists. Several studies have demonstrated similar deficits in their knowledge regarding the use and care of hearing aids. In 1987, Woodford administered a written and practical examination on hearing aids and hearing aid function to 102 speech-language pathologists in West Virginia. The practical portion of the examination required the subjects to evaluate the function of two hearing aids. The results of the study revealed poor performance on both the written and practical test by the speech pathologists. The subjects demonstrated significant deficits in their basic knowledge regarding acoustic feedback, telecoil function, and battery voltage. The results of this practical portion of the examination revealed that only one fourth of the subjects changed the settings on the hearing aid from the telecoil setting to the microphone position appropriately. Less than one fourth of the entire sample completed any of the other functions correctly. Woodford found that those subjects who had some experience working with a hearing-impaired child prior to the study tended to perform better on both the written and the practical portions of the examination. He then assessed the correlation between the amount of education or instruction in hearing aids each subject has and their performance in the examinations. Subjects that had more than two hours of instruction performed better on the written examination than those subjects who had received two hours or less of instruction. The results of the practical examination; however, were relatively equivocal across all subjects. While Woodford's results suggested that knowledge and skill with hearing aid monitoring improves with experience, his primary findings also indicated that the majority of speech-language pathologists do not have the minimum skills necessary to adequately assess hearing aid performance.

Tourne' (1988) investigated the ability of speech-language pathologists to accurately and consistently identify electroacoustic defects in hearing aids by listening checks. The results of her study indicated that speech language pathologists were able to identify internal feedback and inappropriate volume taper with a relatively high degree of accuracy (76%). In addition to this finding, it was noted that there was no correlation between subjects accuracy and their experience with hearing aids. These results indicated that, in some cases, speech-language pathologists do have the ability to accurately assess hearing aid function.

Teachers who specialize in the education of the deaf may receive training in amplification systems and their use; however, most do not feel prepared to accept the responsibility for hearing aid monitoring. Regular classroom teachers, those who are most likely to have hearing-impaired children mainstreamed into their classes, do not usually receive instruction in hearing aids or any other issue involving the habilitation of hearing-impaired children. In general, those school personnel who have been given the responsibility of hearing aid maintenance have not received sufficient instruction in the use, care, and maintenance of hearing aids.

Many aural (re)habilitation programs designed for parents of hearing-impaired children recommend that these parents perform a daily hearing aid check (Thompson, Atcheson & Pious, 1985; Clark and Watkins, 1978). Ling & Ling (1978) advocated that parents should be the individuals responsible for daily listening and visual checks on their child's hearing aids, and have outlined what should be included in these checks. Finally, in early intervention programs and home based intervention where the contact with trained professionals is limited, the task of monitoring the hearing-impaired child's hearing aids inevitably falls upon the parents.

Hearing aid Monitoring Programs For Parents

There have been several studies investigating the effectiveness of hearing aid monitoring programs for teachers, speech-language pathologists, and other professionals (Potts and Greenwood, 1983; Mynders, 1981; Bendet, 1980; Kemker et al., 1979; Hanners and Sitton (1974). These studies, all performed in educational settings, indicated that a properly administrated hearing aid monitoring program can significantly decrease the number of malfunctioning hearing aids.

There is limited information available on the adequacy of the hearing aid monitoring skills of parents of hearing-impaired children. One study indicated that a hearing aid monitoring training program for parents can significantly reduce the number of hearing aid malfunctions. In this study, Diefendorf and Arthur (1987) examined the effectiveness of parent training in hearing aid maintenance. They educated the parents in a variety of topics which included the anatomy of hearing mechanism, the nature and impact of hearing loss, audiogram interpretation, and hearing aid maintenance/function. The program also included training parents in the daily monitoring of hearing aids. They then monitored 10 hearing aids for one year and found that while the number of defects undetected by parents decreased, the parents' knowledge of hearing aid function increased.

Responsibility for training

The issues regarding who should actually be responsible for hearing aid monitoring and who is responsible for training parents remain unresolved. Data based research in this area is lacking. While a variety of professionals have been given responsibility for hearing aid monitoring, the hearing aid dispenser or audiologist has traditionally provided the initial hearing aid fitting, orientation, and follow up. As a result, actual parent or educator training in amplification and their practice with hearing aids is, in many cases, limited or nonexistent. If the hearing aid monitoring skills of the speech-language pathologist and classroom teacher are restricted or limited, it would not seem appropriate for these professionals to engage in parent training. Perhaps the aural rehabilitation specialist, whether an audiologist or speech-language pathologist, should be the professional of choice who should take on this responsibility when available.

Hearing Aid Defects

The studies mentioned previously have indicated that the most common hearing aid defects are also the ones most easily identified. In 1980, Bendet assessed hearing aid status among school aged hearing-impaired children and found the most common problems identified through visual and listening checks were:

1. the hearing aid was not worn,
2. the hearing aid was switched to telephone or off,
3. the batteries were dead, and
4. the earmold was blocked with cerumen.

These were all problems which should be easily identified by the teachers. Gaeth and Lounsbury (1966) and Zink (1972) found that the most common problems in hearing-impaired children's hearing aids were dead batteries and broken or frayed cords. Again, these are problems which should be easily identified and corrected. Diefendorf and Arthur (1987) stated that these simple problems can be easily identified with a simple visual inspection. Electroacoustic malfunctions appear to be much less common and will require a careful and extensive listening assessment if these defects are to be identified in the classroom or therapy setting.

Visual and Listening Checks

Various authors have identified necessary components to a complete listening and visual check on hearing aids. Tourne' and Wynne (1988) compiled these elements into a working protocol (see Appendix C). The elements of the visual inspection consisted of checking for:

1. The battery voltage using a voltmeter,
2. Proper battery insertion,

3. Earmold appearance, including the inspection for any cracks, and open sound vent and bore,
4. Tubing appearance, including the inspection for any cracks, moisture, and debris,
5. connection of the tubing between the earmold and hearing aid,
6. hearing aid casing, including the inspection for presence of cracks and dirt,
7. Microphone condition, including the inspection for damage and debris, and
8. Hearing aid controls, such as insuring that the hearing aid is set at its proper settings and can be adjusted appropriately.

The elements of a listening inspection consisted of checking for:

1. Hearing aid controls and switches - turning the hearing aid off and on, listening for static and intermittent sound,
2 Volume control - adjusting the gain control wheel up and down while listening for linear growth, scratchiness and or dead spots,
3. Variable controls - listening for clear amplification of all five Ling speech sounds and listening for appropriate gain setting for the hearing aid,

4. Hearing aid casing - gently tapping the hearing on all sides to check for interruptions in output or loose connections,
5. Overall sound quality - listening for distortion, static and or reduced gain, and
6. Earmold tubing - checking for feedback

In order to perform an adequate visual and listening check on a hearing aid, a listening stethoscope or a listening earmold and a battery tester were felt to be essential tools. Finally, Tourne' and Wynne recommended that when any defect or malfunction is detected, the parent should see their audiologist or hearing aid dispenser as soon as possible in order to correct the problem and decrease the period of time in which the hearing-impaired child must go improperly aided or simply unaided.

Chapter III: Methods and Procedures

Statement of the Problem

The purpose of this study was to investigate the effectiveness of a parent training program in establishing the behaviors necessary to perform adequate listening checks on hearing aids. Specifically, this study investigated whether or not supplemental videotaped training further improved the performance of listening checks by parents of hearing-impaired children.

Subjects

Two sets of parents of preschool hearing-impaired children participated in this study. The subjects were matched on as many relevant characteristics as possible in order to alleviate sources of variability. These characteristics were determined from an analysis of candidates responses to a simple questionnaire (see Appendix A), and are summarized in Table 1. Parent group A consisted of parents A1 and A2, while parent group B consisted of parents B1 and B2.

Materials

Two Phonic ear 860 PPLC (#258195, #258196) postauricular hearing aids were used during the baseline and training phases. An electroacoustic analysis and listening check by an audiologist, indicated normal function for both hearing aids. An additional ten postauricular hearing aids, six with confirmed defects or

Table 1

Subject characteristics

1. The subject's children had been aided for more than one month, but no more than three months during the period of data collection.

2. The subjects have no other family members who wore hearing aids, including siblings or parents.

3. The subject's hearing-impaired children were no older than three years of age.

4. Each subject's child was fitted binaurally with behind the ear hearing aids.

5. The subjects shared similar eduction backgrounds. There were no parents who had received previous course work in respect to hearing aids or amplification issues.

electroacoustic malfunctions, were used during the extra therapy measures. That is, these ten hearing aids were used to collect data on the accuracy of the subjects ability to identify the defects or malfunctions. Table 2 presents a description of the make, model, and function/defect of the hearing aids. All ten hearing aids were obtained from Starkey Northwest in Portland, Oregon. The function of all ten hearing aids was verified by the lab technicians at Starkey Labs. Two of the hearing aids exhibited gross harmonic distortion. An additional two hearing aids were judged to have inappropriate or nonlinear volume control tapers. The last two hearing aids exhibited clearly visible cracks running the width of the hearing aid. Electroacoustic and listening checks were performed on each of the ten hearing aids prior to their use and at the conclusion of the study. These analyses indicated that the performance of each hearing aid was consistent with the description of the performance provided by Starkey Labs.

A Hal Hen hearing aid stethoscope and a battery tester (voltmeter) was provided to each subject prior to the initiation of the listening check tasks. A recording form was provided for each parent to record their results from the listening checks on the hearing aids with malfunctions (see Appendix B).

A Panasonic color video camera (WV-3250) and Maxell color VHS format video tapes were used to videotape each

Table 2

Description of hearing aids used for extra therapy measures

Type	Make	Model	Serial #	Malfunction
BTE	Telex	337	877402	harmonic distortion
BTE	Telex	334	821754	none
BTE	Unitron	UM60-PP	B947	cracked case
BTE	Widex	F5+M	183929	harmonic distortion
BTE	Oticon	E229	49543	none
BTE	Otosonic	DK-#01	K81396	none
BTE	Oticon	E31V	053845	no volume taper
BTE	Audiotone	A-71	81144	cracked/chipped case
BTE	Widex	691	16650	no volume taper
BTE	Phonic Ear	602CS	59045	none

subject performing the listening checks during the treatment phase. A Panasonic AC02400 video cassette recorder was used to play the recorded data for interobserver scoring.

The "Visual and Listening Checks for Hearing Aids" protocol developed by Tourne' and Wynne (1988) was used for the clinician training in one treatment condition (see Appendix C). The listening check portion from the "Listening in the Classroom" videotape (Berg, 1988) was used for supplemental training in the other treatment condition.

Procedures

Experimental Design. A single subject, alternating treatments design (Barlow and Hayes, 1979) was used to determine the effectiveness of two different training programs in teaching the behaviors necessary to perform a listening check on postauricular hearing aids. An alternating treatments design involves training behaviors under two or more conditions. The different treatments are both administered during the treatment phase, but they are alternated and counterbalanced across two subjects to control for order effects. The purpose of this design is to determine which treatment condition is more effective in changing behavior. In this study, the alternating treatments design was used to compare the effectiveness of the following training procedures: direct parent training in hearing aid monitoring, and direct parent training combined with videotaped training. Figure 1 presents a summary of the experimental design.

Baseline Procedures. The target behaviors are presented in Table 3. They consisted of five visual and five listening behaviors required to perform an adequate listening and visual inspection of hearing aid. The behaviors were scored as the number of behaviors occurring out of the ten total behaviors. During the baseline phase, the performance of each subject met the stability criterion within three trials. The number of behaviors exhibited between trials did not vary by more than 2 points (20%). Baseline data points were collected over a period of one and a half weeks. During baseline trails each subject was instructed to check the presented hearing aid. The following instructions were presented verbally:

> "Please check this hearing aid just as you would your child's hearing aids, prior to putting them on in the morning".

Treatment Procedures. Once the stability criteria had been met, treatment was initiated. Following baseline, one parent (parent A1 from parent group A and parent B1 from parent group B) from set of parents received training. Parent A1 received direct parent training only whereas parent B1 received direct parent training and received access to the training videotape. The other parents (A2

Figure 1. Treatment design

Parents Group A

	Baseline	Parent Training Only	With Videotape Supplement
A1	Baseline Data	Treatment Data	Treatment Data
A2	Baseline Data	Probe Data	Probe Data
A1 & A2	Extra	Therapy Accuracy Data	Measures

Parents Group B

	Baseline	With Videotape Supplement	Parent Training Only
B1	Baseline Data	Treatment Data	Treatment Data
B2	Baseline Data	Probe Data	Probe Data
B1 & B2	Extra-	Therapy Accuracy Data	-Measures

Table 3

Training steps for listening checks

Visual Inspection

1. assessing battery voltage (utilizing a volt meter)
2. proper battery insertion
3. inspect casing for cracks, dirt and debris
4. hearing aid controls set on proper settings
5. inspecting microphone for damage or debris

Listening Check

1. Volume control - listening for linearity, scratchiness or dead spots
2. Sound quality - listening for distortion, static or reduced gain
3. Ling Five sound test /a,u,ʃ,s/ - using the Ling Five sound test as input
4. Hearing aid switches and controls - turning the hearing aid off and on while listening for static, intermittent sound, loose contacts
5. Earmold tubing - removing the receiver from the ear and covering the opening of the earmold while turning the volume control to maximum and listening for feedback.

from parent group A, and B2 from parent group B) were probed for generalization data. That is, they were probed to determine the extent of the carry over of training in the home. After three sessions of the initial treatment conditions for both sets of parents, the treatment conditions were alternated such that parent A1 now received direct parent training and was given the videotape for supplemental training whereas parent B1 only received the direct parent training.

Direct parent training only consisted of clinician directed, parent training following the "Visual and Listening Checks for Hearing Aids"f protocol by Tourne' and Wynne (1988). This training was provided only in the clinic environment. Direct parent training and videotape supplementala training consisted of the training protocol described above combined with videotaped training implemented in the home environment. The videotaped training consisted of the listening check portion of Dr. Fred Berg's videotape "Listening in the Classroom". Both parents receiving the direct parent training were instructed to share the information/training they received with their partner (parents A2 and B2 respectively) after each session.

The clinician training sessions in both treatment conditions were administered three times per treatment condition for a total of six treatment sessions over a two week period of time. Parents A1 and B1 from each parent group were instructed simultaneously, for each of the six training session in order to avoid any possible differences or biases in training. Each session lasted approximately ten minutes. The videotaped training portion in treatment condition 2 consisted of having the subjects view the videotaped training program at home three times during the corresponding treatment phase. Each viewing was documented on a form signed by both spouses/partners in each parent group. Again, the spouse/partner not receiving direct treatment was instructed to view the videotape in the home during this treatment condition with their respective spouse/partner. In addition, the parent receiving direct clinician training was instructed to communicate and share with their partner/spouse the training that they received.

Data was collected at the end of each treatment session for each parent in direct treatment (parents A1 and B1) and consisted of having the subject perform listening check on the hearing aid used in training. The subjects were instructed to keep a log of each item that they inspected on the hearing aids as they proceeded through the inspection in order to assist with observation/data collection. Each treatment phase consisted of three consecutive training sessions.

While, parents A2 and B2 did not receive direct clinician training, probe data were collected two times during each respective treatment phase. Probe data were obtained by having each subject perform a listening check on the hearing aid used in baseline and recording the target behaviors exhibited during the listening check.

Extra Therapy Measures. The extra therapy measures consisted of collecting accuracy data 9 correct identification of malfunctions) during each phase of the study (versus recording the procedures used). Data were collected form both partners in each parent group. The subjects were asked to evaluate the performance of five hearing aids, two of which were within manufacturers specifications, the third with excessive harmonic distortion, the fourth with an inappropriate volume taper and the fifth with cracked casing. A total of ten different hearing aids were used in the above combinations in order to minimize memory effects. Each hearing aid was marked with a identification number. The identification number was randomly assigned during each trial. A recording form (see Appendix B) was provided for each subject to record their own responses. They were given the following instructions:

> "I want you to inspect each of these hearing aids just as if you were checking your own child's hearing aids. Write down whether they pass or fail your inspection on the recording sheet next to the hearing aids corresponding number. Please write down and describe

any problems you discovered and why you may have failed any hearing aid. Do you have any questions?"

Reliability. The interobserver reliability data of dependant (probe and independent (treatment) measures were provided through a comparison of scores obtained from a second observer. The second observer was an audiologist certified by the American Speech-Language and Hearing Association, and who has practiced for five years. Interjudge reliability was determined for baseline and generalization probe data by calculating the number of scoring agreements (between the two observers) divided by the total number of target forms scored (hearing aid monitoring behaviors and correct identification of malfunctions).

Chapter IV: Results

The purpose of this study was to investigate the effectiveness of one parent training program in establishing the behaviors necessary to perform appropriate hearing aid listening checks. Specifically this study investigated whether or not supplemental training improved the learning curve of listening checks by parents of hearing-impaired children. A single subject, alternating treatments design was utilized with two groups of parents of hearing-impaired children.

Performance

The raw data obtained during baseline and the following treatment sessions are presented in Table 4 for parents A. The respective data for parents B is shown in Table 5. Table 6 presents the raw data for both parent groups for comparison. The performance data for parent group A and B are illustrated in Figures 2 and 3. The first treatment condition consisted of clinician directed parent training only, while the other treatment condition consisted of clinician training combined with supplemental videotaped training.

Baseline Baseline measurements of each subjects performance of listening checks on Behind the Ear (BTE) hearing aids was obtained before treatment began. A stable baseline was defined as no more than an average of 2 data points (20%) variation within the basal period and showing

Table 4

Number and percentage of correct response on listening checks for the A set of parents

Session	A1	A2
Baseline		
1	40% (4/10)	20% (2/10)
2	50% (5/10)	30% (3/10)
3	40% (4/10)	20% (2/10)
Direct Parent Training Only		
4	80% (8/10)	30% (3/10)
5	90% (9/10)	
6	80% (8/10)	50% (5/10)
With Videotape Supplement		
7	80% (8/10)	
8	100% (10/10)	70% (7/10)
9	90% (9/10)	70% (7/10)
Extra Therapy		
Baseline		
2	60% (3/5)	40% (2/5)
3	60% (3/5)	60% (3/5)
Direct Parent Training Only		
5	80% (4/5)	60% (3/5)
6	80% (4/5)	
With Videotape Supplement		
8	80% (4/5)	80% (4/5)
9	80% (4/5)	

Table 5

Number and percentage of correct response on listening checks for the B set of parents

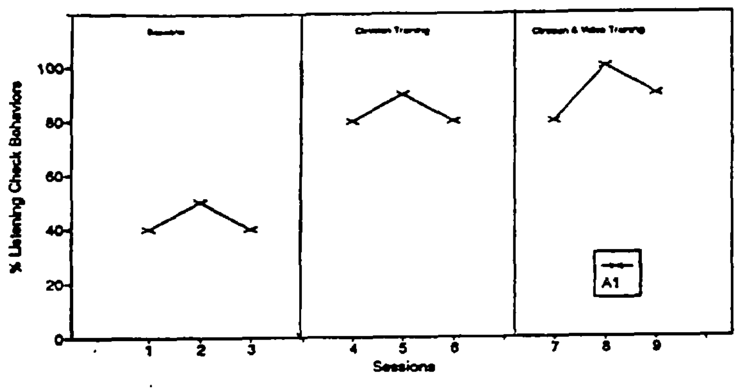
Session	B1	B2
Baseline		
1	30% (3/10)	40% (4/10)
2	40% (4/10)	30% (3/10)
3	40% (4/10)	40% (4/10)
With Videotape Supplement		
4	70% (7/10)	70% (7/10)
5	100% (10/10)	
6	90% (9/10)	80% (8/10)
Direct Parent Training Only		
7	100% (10/10)	
8	100% (10/10)	70% (7/10)
9	90% (9/10)	80% (8/10)
Extra Therapy		
Baseline		
2	60% (3/5)	40% (2/5)
3	40% (2/5)	40% (4/5)
With Videotape Supplement		
5	80% (4/5)	60% (3/5)
6	100% (5/5)	
Direct Parent Training Only		
8	80% (4/5)	80% (4/5)
9	80% (4/5)	

Table 6

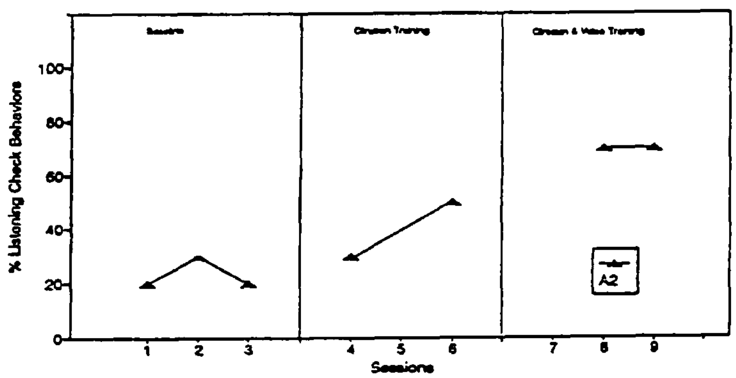
Number and percentage of correct response on listening checks for both sets of parents

Parent	Session	Baseline	Parent Training	With Videotape Supplement	Extra Therapy
A1	1	40% (4/10)			
	2	50% (5/10)			60% (3/5)
	3	40% (4/10)			60% (3/5)
	4		80% (8/10)		
	5		90% (9/10)		80% (4/5)
	6		80% (8/10)		
	7			80% (8/10)	
	8			100% (10/10)	80% (4/5)
	9			90% (9/10)	80% (4/5)
A2 (Probe)	1	20% (2/10)			
	2	30% (3/10)			40% (2/5)
	3	20% (2/10)			60% (3/5)
	4		30% (3/10)		
	5				
	6		50% (5/10)		60% (3/5)
	7				
	8			70% (7/10)	
	9			70% (7/10)	80% (4/5)
B1	1	30% (3/10)			
	2	40% (4/10)			60% (4/5)
	3	40% (4/10)			40% (4/5)
	4			70% (8/10)	
	5			100% (10/10)	80% (4/5)
	6			90% (9/10)	100% (5/5)
	7		100% (10/10)		
	8		100% (10/10)		80% (4/5)
	9		90% (9/10)		80% (4/5)
B2 (Probe)	1	40% (3/10)			
	2	30% (4/10)			40% (2/5)
	3	40% (4/10)			40% (2/5)
	4			70% (7/10)	
	5				
	6			80% (8/10)	60% (3/5)
	7				
	8		70% (7/10)		
	9		80% (8/10)		80% (4/5)

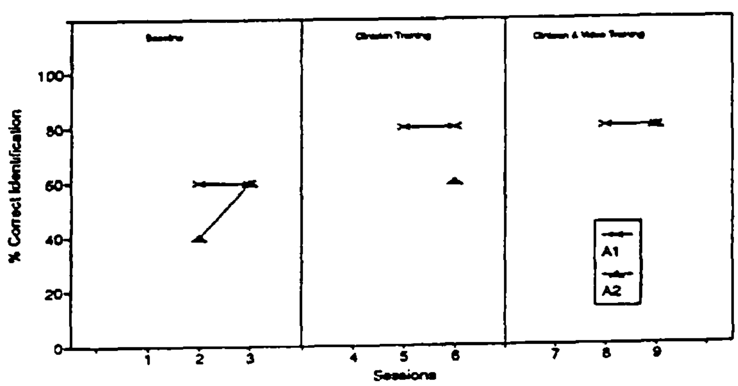
Figure 2. Listening check performance as demonstrated by parent group A.



Treatment Data

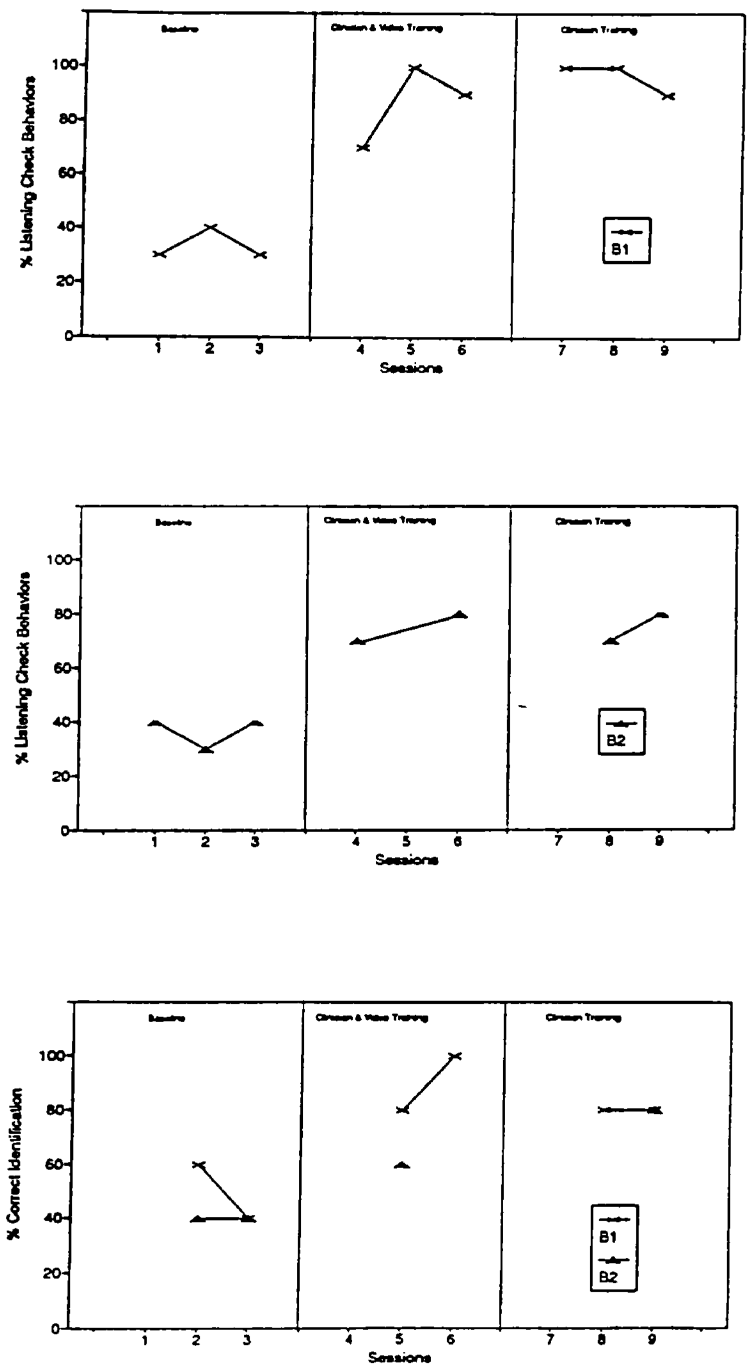


Probe Data



Extratherapy Data

<u>Figure 3.</u> Listening check performance as demonstrated by parent group B.



Treatment Data

Probe Data

Extratherapy Data

no consistent improvement in performance. Each subject achieved baseline stability within three sessions. Baseline measures ranged from 20% to a high of 50% of the measured behaviors across all four subjects. Visual inspection of the data indicated a relatively stable performance during the baseline phase across subjects. In addition, each subject met the stability requirements specified (within 2 data points) for the study.

<u>Treatment</u> Visual inspection of the data during the treatment phases indicated a sharp increase in the frequency of the target behaviors for both parents receiving clinician directed treatment (parent A1 and B1) above previously obtained baseline levels, regardless of their access to the videotape supplement. The frequency of behaviors increased from a baseline average of 43% up to an average of 83.3% during for parent A1 and from a baseline average of 36% to an average of 86.6% for parent B1. Due to the rapid increase of the subjects' performances during the first treatment phase, the performance of both of these subjects plateaued during their second treatment phase, showing relatively no change in performance with a change in treatment. Furthermore, subjects A1 and B1 demonstrated essentially equivocal performance across all treatment conditions. Thus, both direct parent training only and direct parent training combined with supplemental videotaped training appeared to be equally effective in

increasing listening check behaviors.

Data collected on parents A2 and B2 (the parents who did not receive direct clinician training) are also presented in Tables 4, 5, and 6. Again baseline measures appear relatively stable (within one data point) for both subjects. A visual inspection of the learning curves indicated an upward trend or increase in the measured behaviors for each subject during the treatment phase. Parent A2 increased from a baseline average of 25% to an average of 40% during parent directed treatment condition. Parent B1 increased from a baseline average of 39% to an average of 75% during parent directed and videotape training treatment condition. The degree of slope or the learning curve was sharper for parent B2, who's partner/spouse received treatment condition two (combiner clinician training and videotaped training) initially.

Extra Therapy Data. Generalization probe data (measures of subject accuracy in detecting actual hearing aid malfunctions) are presented in Table 6. Both parent groups (all four subjects) performance in detecting actual malfunctions demonstrated improvement. Finally, all four subjects failed to correctly identify the hearing aids with excessive harmonic distortion. In the large majority of cases, they indicated that these hearing aids were functioning appropriately.

Reliability. The subjects were videotaped as they performed the listening checks during the treatment phase. The videotapes were viewed by two observers who recorded the listening check behaviors exhibited during their assessment of the hearing aids. The recording form for observation of listening checks is presented in Appendix E. The two judges agreed across 94% of the observations recorded.

Chapter V: Discussion

This study addressed the effectiveness of clinician/parent training and supplemental videotaped training in improving the performance of listening checks on behind the ear hearing aids (BTE). The results of this study indicated that parent training was effective in increasing the behaviors necessary to perform an adequate listening check on behind-the-ear hearing aids. As a result of parent training, the subjects ability to correctly identify hearing aid defects increased. The data also indicated that supplemental videotaped training appeared to facilitate learning in a parent who was not receiving direct parent training from a clinician.

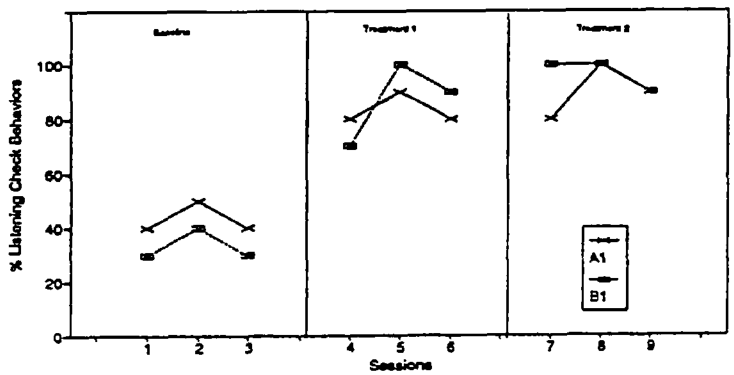
Baseline measurements met the stability requirements specified (within 2 data points) during the first three sessions. The level at which the behaviors occurred during baseline was appropriate for use in the study, as the behaviors were not occurring at high level (35% average) during the pretreatment measures. This supported previous research (Diefendorf and Arthur, 1987, Gaeth and Lounsbury, 1966) indicating that parents are not typically highly trained in performing listening checks. There was no pronounced slope among the baseline measures for any one subject. It was concluded that the baseline behaviors presented in this study, represented those behaviors developed and habitually used prior to the participation in the treatment program.

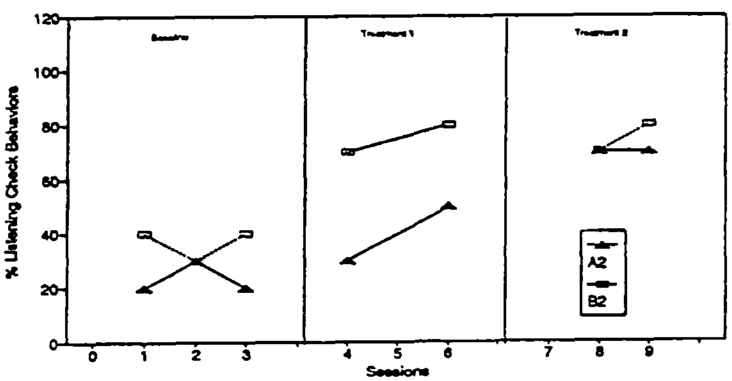
During baseline measures, none of the subjects manipulated the switches of the hearing aids (MT) other than to initially turn the hearing aid on. It was noted that none of the subjects utilized the Ling five sound test during baseline. Instead, the subjects used the following vocal input: counting, "one, two, three, one, two, three", "testing, testing", and "ba,ba,ba". Finally, the subjects did not comment on the sound quality of any of the hearing aids during the baseline measures.

The appropriate trends and slopes support the conclusion that the treatment phase was responsible for the increase in listening check behaviors. The trend demonstrated an increase in the behaviors for both parents receiving direct parent training (parent A1 and B1). The frequency of appropriate listening check behaviors increased from a baseline average of 43% to an average of 83.35% for parent A1 (clinician only initially) and from a baseline average of 36% to an average of 86% for parent B1 (combined clinician and videotaped training initially) during the initial treatment conditions respectively. Both treatment conditions appeared to have equivocal results as is illustrated in Figure 4.

In addition, data collected on parents A2 and B2 (who did not receive any direct clinician training) indicated an upward trend or increase in the measured behaviors during

<u>Figure 4.</u> A comparison of listening check performance between parent group A and parent group B.





the initial treatment phase. The frequency of parent A2's listening check behaviors increased from a baseline average of 25% to an average of 40% (no direct treatment) whereas the frequency of parent B2's listening check behaviors increased from a baseline average of 39% to an average of 75% (videotape viewing only). It should be noted that the learning curve was not as sharp for the parent (A2) who did not have access to the supplemental videotape training.

The dependant variable was generalized to untrained probes of identifying malfunctions in the ten hearing aids. The ability of all subjects to correctly identify the hearing aid defects increased, including the parents A2 and B2 who did not receive any direct clinician training. This finding is most likely due to information sharing. As the parents who received the direct parent training were instructed to share the information they received with their spouse and both parents showed performance increases, the data suggest that information sharing may be beneficial as well as cost effective.

Extraneous Factors

The physical presence of the listening check equipment (battery tester and listening stethoscope) may have contributed to the consistency demonstrated in checking the battery voltage and/or listening to the hearing aid throughout the study. It is probable that the presence of the equipment functioned as a reminder of their use. In addition, some of the differences in the performance levels demonstrated between the parents who received direct parent training and those who did not may have been due to the learning environment of the clinic, which may be less passive than in the home.

Parents A1 and B1 (those who received direct parent training) were asked at the end of the study how they shared the clinician training information with their spouse and if they could estimate how much of this information was truly shared. Both subjects indicated that they passed the information along verbally, with parent B1 reporting that she physically sat down with her spouse and demonstrated the training following the initial training session. Both subjects revealed that they did not continue to share detailed information after the initial training session as they felt that no new information was provided; however, they did perform listening checks on their children's hearing aids in the presence of their spouse.

Traditional parenting roles may be a confounding factor in generalizing the findings of this study. Both parents who received direct parent training (parents A1 and B1) were the mothers of the hearing-impaired children while the other parents who did not receive direct parent training (A2 and B2) were the fathers of the hearing-impaired children. As both families followed traditional family roles (the father working with the mother at home and primarily responsible for the needs of the hearing-impaired child), the generalization of any data regarding parent training effectiveness and hearing aid monitoring skills between mothers and fathers cannot be made to other less traditional families. Parental involvement varies among all families, and generally, while the mother continues to be the primary care taker, in some families the father may be more involved in child care and rearing. Still, in other families both parents may be equally as involved. Regardless of the assumption of roles, the degree of involvement can change over time. As a consequence, the results of this study can not be generalized to parental roles.

Accuracy Identifying Malfunctions

The subjects ability to identify defective hearing aids did not improve as much as expected. The subjects most often correctly identified the adequately functioning hearing aids, then those hearing aids with inappropriate volume controls, those with cracked casing, and, with the least accurately, those with harmonic distortion (see Appendix F). It might be suggested that more experience listening to defective hearing aids is needed in addition to practice with normally functioning hearing aids. However, Busenbark and Jenison (1985) concluded that experience and expertise in the proper functioning of hearing aids could not be equated. Further research in this area is warranted.

Clinical Implications

The data obtained in this study indicated that parents of hearing-impaired children can learn and demonstrate those behaviors necessary to perform adequate or appropriate listening checks on behind the ear hearing aids through direct and indirect parent training. The data also indicated that parents could identify certain hearing aid malfunction accurately (see Appendix F). Together, these findings support the suggestion that parents of hearing-impaired children are the appropriate persons for assuming the responsibility for daily monitoring of their children's hearing aids (Thompson, Atcheson and Pious, 1985, Clark and Watkins, 1978, Ling and Ling, 1978). Furthermore, the data regarding videotaped training indicated that videotaped training may be an effective tool in improving the performance of listening checks and in the detection of hearing aid malfunctions. This suggests that a videotaped training program may be helpful for family use when not all family members are able to attend the initial hearing aid orientation and fitting or for follow up sessions. In addition, this type of training program may be used where clinician training and follow up in hearing aid monitoring is impractical or impossible.

Further Research

Though four subjects is not representative of all parents of hearing-impaired children, these results provide important information regarding the benefits of parent training and possible videotaped training procedures. For this reason, the study warrants replication. Replication refers to the reproduction of the experiment or procedure, and, as such, replications are necessary to the evaluation of treatment effectiveness. This could include direct replication of the same experiment with more subjects and or differing subject groups (such as nontraditional families, grandparents and others). It should be remembered, though, that single subject designs have some form of replication built into them.

Additional studies may attempt to examine the amount of parent training typically provided to parents of hearing-impaired children through audiologists and hearing aid dispensers in order to assess what information may be left out or what practical changes could be made. Another possible study could examine the effectiveness of group parent training, or one time "refresher" sessions for parents.

Research is also needed in the area of listening checks regarding listening experience and in the identification of acoustical malfunctions and harmonic distortion. For example, what is the correlation between experience and accuracy in identifying electroacoustic hearing aid malfunction?

Conclusion

Parents of hearing-impaired children are continually faced with the problem of obtaining and maintaining the most optimal performance form their child's hearing aids. The importance of adequately functioning hearing aids in a child's aural habilitation program has been well documented. Though there has been only limited research investigating the monitoring skills of parents and the effectiveness of parent training, the present study indicates that parents can be effective in monitoring the function of the hearing aids worn by their hearing-impaired children. Additionally, the findings indicate that supplemental videotaped training may be an effective means for implementing parent training. However, further or continued training is necessary to ensure that parents would perform appropriate listening checks. Audiologists and hearing aid dispensers who fit children with hearing aids may need to make modifications in service delivery to insure adequate training and practice with hearing aid monitoring in order to enable parents to perform adequate and effective listening checks on hearing aids. Detailed parent training should be implemented during follow-up visits, and or a home training program accompanied by a method of reporting and phone contacts could be designed.

Most importantly, the need continues to exists for parents and professionals alike to recognize the importance of hearing aid monitoring and maintenance to ensure consistent and appropriate amplification in order to meet the needs of our hearing-impaired children.

References

American National Standards Institute. (1969). Specifications for audiometers, ANSI S3.6-1969. New York: ANSI.

American National Standards Institute. (1982). Specifications of hearing aid characteristics, ANSI S3.22-1982. New York: ANSI.

American Speech and Hearing Association. (1973). Standards and guidelines for comprehensive language, speech, and hearing programs in the schools. Asha,

Bendet, R. M. (1980). A public school hearing aid maintenance program. Volta Review, 82, 149-155.

Berg, F. S. (1987). Facilitating classroom listening. Boston, MA: College-Hill Press.

Berg, F. S. (Producer). (1988). Listening problems in the classroom [Videotape]. Logon, UT: Utah State University.

Berg, F. S., Blair, J.C., Viehweg, S. H., & Wilson-Vlotman, A. (1986). Educational audiology for the hard of hearing child. Orlando, FA: Grune & Stratton.

Bess, F. H. (1977). Condition of hearing aids worn by children in a public school setting. In F. B. Withrow (Ed.), The condition of hearing aids worn by children in a public school program (Report No. (DE) 77-05002, Grant Number: OEG-4-71-0060). Washington, D.C.: U.S. Department of Health, Education, and Welfare--Office of Education. (pp. 11-24).

Bess, F. H., & McConnel, F. E. (1981). Audiology, education, & the hearing-impaired child. St. Louis, MO: C.V. Mosby.

Blair, J.C., Wright, K., & Pollard, G. (1981). Parental knowledge and understanding of hearing loss and hearing aids. Volta Review, 83, 375-382.

Bode, D. L., & Kasten, R. N. (1971). Hearing aid distortion and consonant identification. Journal of Speech and Hearing Research, 14, 323-331.

Busenbark, L., & Jenison, V. (1986). Assessing hearing aid function by listening check. Volta Review, 88, 263-268.

Chial, M. R. (1977). Electroacoustic assessment of children's hearing aids; Repeatability of measurement and determination of merit. In F. B. Withrow (Ed.), The condition of hearing aids worn by children in a public school program (Report No. (DE) 77-05002, Grant Number: OEG-4-71-0060). Washington, D.C.: U.S. Department of Health, Education, and Welfare--Office of Education. (pp 25-52).

Clark, R. C., and Watkins, S. W. (1985). The SKI*HI Model: programming for hearing-impaired infants through home intervention; Home visit curriculum (4th ed.). Logon, UT: Utah State University.

Clezy, G. (1984). An early auditory-oral intervention program. In D. Ling (Ed.), Early intervention for hearing impaired children: Oral options. San Diego, CA: College Hill Press.

Curran, J. R. (1985). ITE aids for children: Survey of attitudes and practices of audiologists. Hearing Instruments, 36(4), 20, 22, 25.

Diefendorf, A., & Arthur, D. (1987). Monitoring children's hearing aids: Re-examining the program. Volta Review, 89, 17-26.

Elfenbein, J. L., Bentler, R. A., Davis, J. M., & Niebuhr, D. P. (1986, November). Status of school children's hearing aids related to monitoring practices. Paper presented at the Convention of the American Speech, Language, and Hearing Association, Detroit, MI.

Ewing, A. W. G., Ewing, I. R., & Littler, T. S. (1936). The use of hearing aids. Medical Research Council Report, London, United Kingdom.

Gaeth, J.H., & Lounsbury, E. (1966). Hearing aids and children in elementary schools. Journal of Speech and Hearing Disorders, 31, 283-285.

Hanners, B. A., & Sitton, A. B. (1974). Ears to hear: A daily hearing aid monitoring program. Volta Review, 76, 530-536.

Harris, J., Haines, H., Kelsey, P., & Clark, T. (1961). The relation between speech intelligibility and the electroacoustic characteristics of low fidelity circuitry. Journal of Auditory Research, 1, 357-381.

Hodgson, W. R., & Skinner, P. H. (Eds.), (1981). Hearing aid assessment and use in audiologic habilitation (2nd ed.). Baltimore, MD: Williams & Wilkins.

Jeffers, J., Behrens, T., & Rubin, M. (1973). Task force I: Standards for hearing aids. Journal of the Academy of Rehabilitative Audiologists, 6, 13-19.

Jerger, J., Speaks, C., & Malmquist, C. (1966). Hearing aid performance and hearing aid selection. Journal of Speech and Hearing Research, 9, 136-149.

Jirsa, R. E., & Hodgson, W. R. (1970). (1970). Effects of harmonic distortion in hearing aids on speech intelligibility for normals and hypacusics. Journal of Auditory Research, 10, 213-217.

Jones, K. (1982). The role of educational audiologists as viewed by school administrators, regular classroom teachers who serve hard of hearing children, and speech-language pathologists. Unpublished master's thesis, Utah State University, Logon, Utah.

Kasten, R. N., & Franks, J. R. (1981). Electroacoustic characteristics of hearing aids. In W. R. Hodgson and P. H. Skinner (Eds.), Hearing aid assessment and use in audiologic habilitation (2nd ed.). Baltimore: MD: Williams & Wilkins.

Kemker, F. J., McConnell, F., Logan, S. A., & Green, B. W. (1979). A field of study of children's hearing aids in a school environment. Language, Speech, and Hearing Services in Schools, 10, 47-53.

Lass, N. J., Tecca, J. E., & Woodford, C. M. (1987). Teacher's knowledge of, exposure to, and attitudes toward hearing aids and hearing aid wearers. Language, Speech, and Hearing Services in Schools, 18, 86-95.

Ling, D. (1975). Amplification for speech. In D. R. Calvert and S. R. Silverman (Eds.), Speech and deafness. Washington, DC: A.G. Bell Association for the Deaf.

Lotterman, S. H., & Kasten, R. N. 91967). The influence of gain control rotation on nonlinear distortion in hearing aids. Journal of Speech and Hearing Research, 10, 593-99.

Mynders, J. M. (1981). Why hearing aid maintenance in the public schools? Hearing Instruments, 34(3), 9, 35.

Niswander, P. S. (1989). Listening checks on hearing instruments. Hearing Instruments, 40(4), 38, 55.

Northern, J. L., & Downs, M. P. (1984). Hearing in children (3rd ed.). Baltimore, MD: Williams & Wilkins.

Pollack, M. C. (Ed.). (1980). Amplification for the hearing-impaired. New York: Grune & Stratton.

Porter, T. A. (1973). Hearing aids in a residential school. American Annals of the Deaf, 118, 31-33.

Potts, P. L. & Gree3nwood, J. 91983). Hearing aid monitoring: Are looking and listening enough? Language, Speech, and Hearing Services in Schools, 14, 157-163.

Robinson, D. O., & Sterling, G. R. (1980). Hearing aids and children in school: A follow-up study. Volta Review, 82, 229-235.

Ross, M. (1976). Model educational cascade for hearing-impaired children. In G. Nix (Ed.), Mainstream education for hearing impaired children and youth. New York: Grune & Stratton.

Thompson, M. D., Atcheson, M. A., & Pious, C. G. (1985). Birth to three: A curriculum for parents, parent trainers, and teachers of very young hearing-impaired children. Seattle, WA: University of Washington Press.

Tourne', P. M. (1988). Measurment of the validity and reliability of hearing aid listening checks as performed by speech-language pathologists. Unpublished master's thesis, University of Montana, Missoula, MT.

Tourne', P. M. & Wynne, M. K. (1988). Visual and listening checks for hearing aids. Unpublished paper.

Withrow, F.B. (Ed.). (1977). The condition of hearing aids worn by children in a publich schhol program (Report No. (DE) 77-05002, Grant Number: OEG-4-71-0060). Washington, D.C.: U.S. Department of Health, Education, and Welfare-Office of Education.

Woodford, C. M. (1987). Speech-language pathologist's knowledge and skills regarding hearing aids. Language Speech, and Hearing Services in Schools, 18, 312-322.

Zink, G. D. 91972). Hearing aids children wear: A longitudinal study of performance. Volta Review, 74, 41-52.

Appendix A

Subject Questionnaire

1. Age of Hearing-Impaired child: ______

2. Age of Parent: ______

3. Family members with hearing aids (please list by relationship)

____

____

____

____

4. List any classes or education you might have had regarding
hearing aids or hearing-impairment:

____

____

____

____

5. How long has your child worn hearing aids? ______

6. What is the highest level of education you attained? eg. 8th grade, high school graduate, any college etc.

____

7. Did your hearing aid dispenser/audiologist provide you with
information or training on how to make sure your child's
hearing aids are working properly? If so what?

____

____

____

____

Appendix B

Recording Form for Listening Checks

Subject Number: ______________________ Date: ____________

Hearing Aid #	PASS	FAIL	If Fail, Please Describe Problem
1.	P	F	____________________
2.	P	F	____________________
3.	P	F	____________________
4.	P	F	____________________
5.	P	F	____________________

- -

(To be filled out by clinician)

Phase of study ______________________

Comments:

____

____

____

Appendix C

Visual and Listening Checks

by

Patrice Tourne' and Michael K. Wynne

A hearing aid check involves both a visual and listening assessment. The visual check generally involves inspecting each normally visible component of a hearing aid system for problems. The visual component of the check typically includes assessing the following:

1. battery voltage (utilizing a volt meter),
2. proper battery insertion,
3. earmold appearance (e.g., presence of cracks, rough areas, patent vent and sound bore),
4. tubing appearance (e.g., presence of cracks, dirt),
5. connection of tubing to earmold and hearing aid,
6. hearing aid casing (e.g., presence of cracks, dirt),
7. microphone integrity (e.g., visible damage; presence of debris), and
8. hearing aid controls (e.g., proper settings; appropriate maneuverability).

A listening check entails listening to the sound output of the hearing aid system for problems while manipulating the sound output and controls of the hearing aid. Several listening check protocols have been described by various authors (Berg, 1987; Thompson, et al., 1985; Potts and Greenwood, 1983; Hodgson and Skinner, 1981; Ling and Ling, 1978; Ling, 1979). While the components of these listening check protocols vary somewhat, most of these protocols consist of the same basic elements. A conventional listening check, as described by Potts and Greenwood (1983), involves assessment of the following aspects of the hearing aid (using the Ling Five Sounds as input, and with the hearing aid coupled to the listener's ear):

1. hearing aid controls/switches (turn the hearing aid on and off, listen for static, intermittent sound or loose contacts),
2. volume control (turn volume control up and down, slowly while listening for scratchiness, dead spots, or non-linear growth in volume),
3. variable controls (listening for clear amplification of all five speech sounds; listening for appropriate gain setting for the hearing aid),

4. hearing aid casing (gently tapping the hearing aid on all sides to check for interruptions in amplification or loose connections),
5. overall sound quality (listening for distortion, static, reduced gain), and
6. earmold tubing (remove the receiver from the ear and cover the opening of the earmold: turn down the volume control to maximum gain, listening for acoustic feedback).

These listening checks should be performed with the hearing aid gain settings in the position normally used by the child, or adjusted to provide as much output as the listener can tolerate comfortably, since this generally approaches the power output required by the child (Ling, 1975). The hearing aid should also be coupled to the listeners ear with a hearing aid stethoscope or a custom fitted earmold, an adapter, and a connecting tube. The Ling Five Sounds (Ling, 1978) are conventionally used as input when assessing the acoustic properties of a hearing aid. These sounds, /u,a,i,s,ʃ/ are felt to represent sample points across the entire range of speech frequencies, thus enabling the listener to identify the presence of significant distortion occurring at any frequency within the speech range (250 Hz to 4000 Hz).

When the listening check indicates any possible malfunction, the parents should be notified in writing regarding the exact nature of the problem. Parents should also be provided with instructions regarding the need for repairs. Finally, appropriate referrals to the child's hearing aid dispenser or audiologist should be provided to the parents.

Appendix D

Videotape Viewing Record

I have viewed the listening check portion of the videotape provided to me. The date of each viewing and the corresponding verification signture is recorded below:

Date Viewed	Verification Signature
____________	__________________________
____________	__________________________
____________	__________________________
____________	__________________________

Appendix E

Scoring Forms for Hearing Aid Evaluation Behaviors

Subject Number: ______________ Phase of Study: _________

- -

Behavior	YES(a) correct	YES(b) incorrect	NO
Visual			
1. check battery voltage	Ya	Yb	N
2. proper battery insertion	Ya	Yb	N
3. casing - cracks, dirt, debris	Ya	Yb	N
4. controls on proper setti	Ya	Yb	N
5. microphone inspec	Ya	Yb	N
Listening			
1. volume control linearity	Ya	Yb	N
2. Ling Five Sound Test as input	Ya	Yb	N
3. sound qualitiy - distortion?	Ya	Yb	N
4. manipulate controls w/input	Ya	Yb	N
5. earmold tubing - feedback when cupped	Ya	Yb	N

Notes:

Appendix F

Frequency of listening check behaviors

Listening check behaviors	# times performed
1. Controls on proper setting	32
2. Checking for feedback	31
3. Proper battery insertion	27
4. Checking battery voltage	25
5. Inspecting casing	22
6. Ling five sounds	18
7. Volume control linearity	15
8. Sound quality - distortion	15
9. Microphone inspection	8
10. Manipulate controls and switches	8

Appendix G

Listening Problems In The Classroom
by
Fred Berg, Ph.D. 1988

Length: 38 minutes total
11 minutes listening check section

Topics

Imposing a hearing loss on self

Immittance bridges and tympanograms

Identifying symptoms of hearing and auditory perceptual problems

Audiometers and audiograms

Five Sound Test

Calculating reverberation time

Behind The Ear and In The Ear hearing aids

- overall description hearing aids
- batteries - description of batteries, use and how to check voltage
- **Visual Check**
  - conducted daily
  - inspect each visible part of the hearing aid
  - check the following:
    a. battery and compartment
    b. hearing aid case
    c. volume control
    d. switches
    e. earhook
    f. tubing
    g. earmold

  Report any problems to school/audiologist
- Squeal check - check for feedback at various volumes. Work from earmold back to aid to locate problem.
- **Listening Check**
  - conducted daily
  - check the following
    a. use of listening stethoscope
    b. on/off switch, turning aid on M position

c. Listen to internal noise with volume control turned down
d. Ling Five Sound test while listening to hearing aid
f. distortion - short description of distortion

- Preventative servicing of hearing aid
    - moisture
        a. dry pack
    - dirty aid
        a. cerumen in sound bore
        b. debris in the microphone
        c. cleaning/disinfecting
    - dead hearing aid
        a. dead battery
        b. clean battery contacts

Personal FM Systems